

# Wind tunnel AER stats

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Get wind tunnel data only.

```
wsumm <- subset(isumm, meas.tech == 'Wind tunnel')
dfsumm(as.data.frame(wsumm))
```

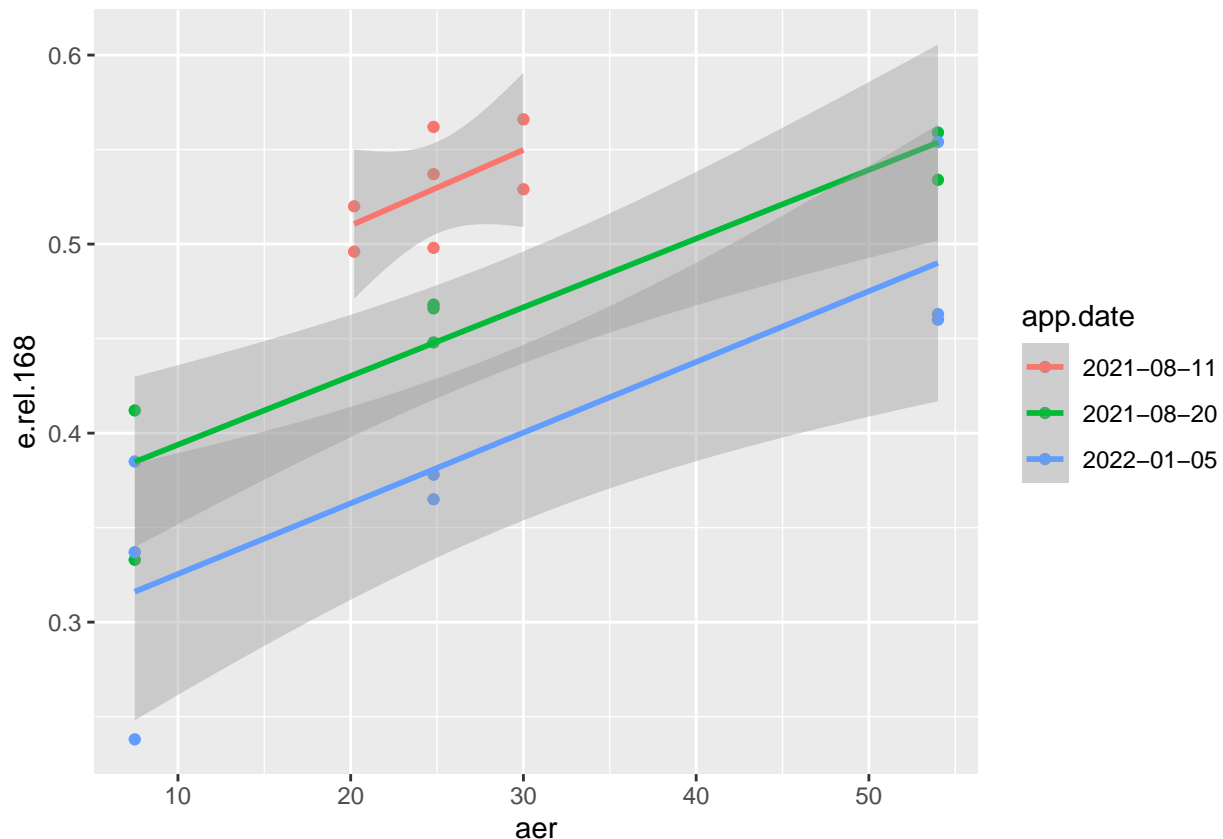
```
##
## 22 rows and 28 columns
## 22 unique rows
##
##      trial.nm  app.date  pmid  meas.tech meas.tech2  aer
## Class      character character integer  character  character numeric
## Minimum      A 11 Aug 2021-08-11    1904 Wind tunnel      wt      7.5
## Maximum      C 05 Jan 2022-01-05    1925 Wind tunnel      wt      54
## Mean          <NA>      <NA>    <NA>      <NA>      <NA>      27.6
## Unique (excl. NA)      3      3      22      1      1      5
## Missing values      0      0      0      0      0      0
## Sorted          TRUE      TRUE      TRUE      TRUE      TRUE      FALSE
##
##      aer.grp      cta air.temp.mean air.temp.min
## Class      factor numeric      numeric      numeric
## Minimum      Low 7 or 20    181      2.46      -3.4
## Maximum      High 30 or 54    211      15.4      11.4
## Mean          Medium 25    193      10.5      4.93
## Unique (excl. NA)      3      3      6      6
## Missing values      0      0      0      0
## Sorted          FALSE      FALSE      FALSE      FALSE
##
##      air.temp.max wind.2m.mean wind.2m.min wind.2m.max rain.cum
## Class      numeric      numeric      numeric      numeric      numeric
## Minimum      8.5      0.1      0.1      0.1      0
## Maximum      22.3      0.72      0.72      0.72      0
## Mean          17.1      0.367      0.367      0.367      0
## Unique (excl. NA)      6      5      5      5      1
## Missing values      0      0      0      0      0
## Sorted          FALSE      FALSE      FALSE      FALSE      TRUE
##
##      rain.cum.48 j.NH3.mean j.NH3.min j.NH3.max e.cum.final
## Class      numeric      numeric      numeric      numeric      numeric
## Minimum      0      0.0763      0      0.431      16.1
## Maximum      0      0.218      0.0309      3.54      39.4
## Mean          0      0.165      0.0105      2.2      31.4
## Unique (excl. NA)      1      20      19      22      22
## Missing values      0      0      0      0      0
## Sorted          TRUE      FALSE      FALSE      FALSE      FALSE
```

```
##
##           e.cum.final.gaps e.rel.final e.cum.168 e.rel.168
## Class           numeric      numeric  numeric   numeric
## Minimum          16.1        0.261    14.7     0.238
## Maximum          39.4        0.585    39.2     0.566
## Mean             31.4        0.472    30.7     0.459
## Unique (excl. NA)    22         22     21      22
## Missing values      0         0       0       0
## Sorted            FALSE      FALSE    FALSE    FALSE
##
##           e.cum.168.sum e.cum.168.gaps n.int.168 n.int.168.gaps
## Class           numeric      numeric   integer    integer
## Minimum          14.6        14.6      96         96
## Maximum          39.2        39.2     126        126
## Mean             30.6        30.6    <NA>        <NA>
## Unique (excl. NA)    22         22       3         3
## Missing values      0         0       0         0
## Sorted            FALSE      FALSE    FALSE    FALSE
##
```

Take a look.

```
ggplot(wsum, aes(aer, e.rel.168, colour = app.date)) +
  geom_point() + geom_smooth(method = lm)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



Clear response of emission to AER within each field trial.

Apply linear model.

```
m1 <- lm(e.rel.168 ~ wind.2m.mean + factor(app.date), data = wsumm)
summary(m1)

##
## Call:
## lm(formula = e.rel.168 ~ wind.2m.mean + factor(app.date), data = wsumm)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.07898 -0.02104  0.00205  0.01969  0.06802
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.43729    0.01878  23.288 6.86e-15 ***
## wind.2m.mean      0.27766    0.03730   7.444 6.73e-07 ***
## factor(app.date)2021-08-20 -0.08161    0.01999  -4.083 0.000698 ***
## factor(app.date)2022-01-05 -0.14808    0.01941  -7.630 4.78e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03727 on 18 degrees of freedom
## Multiple R-squared:  0.8505, Adjusted R-squared:  0.8256
## F-statistic: 34.13 on 3 and 18 DF,  p-value: 1.224e-07

anova(m1)

## Analysis of Variance Table
##
## Response: e.rel.168
##           Df Sum Sq Mean Sq F value    Pr(>F)
## wind.2m.mean      1 0.061343  0.061343   44.157 3.091e-06 ***
## factor(app.date)  2 0.080901  0.040450   29.117 2.281e-06 ***
## Residuals       18 0.025006  0.001389
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

confint(m1)

##              2.5 %      97.5 %
## (Intercept)    0.3978431  0.47674440
## wind.2m.mean    0.1992941  0.35602241
## factor(app.date)2021-08-20 -0.1236047 -0.03962312
## factor(app.date)2022-01-05 -0.1888543 -0.10730666

drop1(m1, test = 'F')

## Single term deletions
##
## Model:
## e.rel.168 ~ wind.2m.mean + factor(app.date)
##           Df Sum of Sq      RSS      AIC F value    Pr(>F)
## <none>                 0.025006 -141.15
## wind.2m.mean      1  0.076980  0.101985 -112.23  55.412 6.731e-07 ***
## factor(app.date)  2  0.080901  0.105907 -113.40  29.117 2.281e-06 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

P = 6.7E-7 for AER effect.

Look at interaction term.

```
m2 <- lm(e.rel.168 ~ wind.2m.mean * factor(app.date), data = wsumm)
summary(m2)
```

```
##
## Call:
## lm(formula = e.rel.168 ~ wind.2m.mean * factor(app.date), data = wsumm)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.078155 -0.020631  0.002827  0.019955  0.068845
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)          0.42960    0.10214   4.206  0.00067
## wind.2m.mean          0.30076    0.30357   0.991  0.33656
## factor(app.date)2021-08-20 -0.07197    0.10589  -0.680  0.50645
## factor(app.date)2022-01-05 -0.14150    0.10504  -1.347  0.19671
## wind.2m.mean:factor(app.date)2021-08-20 -0.02831    0.31000  -0.091  0.92838
## wind.2m.mean:factor(app.date)2022-01-05 -0.02026    0.30792  -0.066  0.94836
##
## (Intercept)                ***
## wind.2m.mean
## factor(app.date)2021-08-20
## factor(app.date)2022-01-05
## wind.2m.mean:factor(app.date)2021-08-20
## wind.2m.mean:factor(app.date)2022-01-05
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03951 on 16 degrees of freedom
## Multiple R-squared:  0.8506, Adjusted R-squared:  0.804
## F-statistic: 18.22 on 5 and 16 DF,  p-value: 4.231e-06
```

```
anova(m2)
```

```
## Analysis of Variance Table
##
## Response: e.rel.168
##              Df    Sum Sq Mean Sq F value    Pr(>F)
## wind.2m.mean    1  0.061343  0.061343  39.2887 1.121e-05 ***
## factor(app.date)  2  0.080901  0.040450  25.9075 9.602e-06 ***
## wind.2m.mean:factor(app.date)  2  0.000024  0.000012   0.0078   0.9922
## Residuals      16  0.024981  0.001561
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
confint(m2)
```

```
##              2.5 %      97.5 %
## (Intercept)    0.2130726  0.64613649
## wind.2m.mean   -0.3427749  0.94429263
```

```
## factor(app.date)2021-08-20      -0.2964542  0.15251637
## factor(app.date)2022-01-05      -0.3641742  0.08117394
## wind.2m.mean:factor(app.date)2021-08-20 -0.6854840  0.62887163
## wind.2m.mean:factor(app.date)2022-01-05 -0.6730248  0.63251020

drop1(m2, test = 'F')

## Single term deletions
##
## Model:
## e.rel.168 ~ wind.2m.mean * factor(app.date)
##              Df Sum of Sq      RSS      AIC F value Pr(>F)
## <none>                0.024981 -137.18
## wind.2m.mean:factor(app.date)  2  2.4494e-05  0.025006 -141.15   0.0078  0.9922

P = 0.99 for interaction.
```